AD 410169

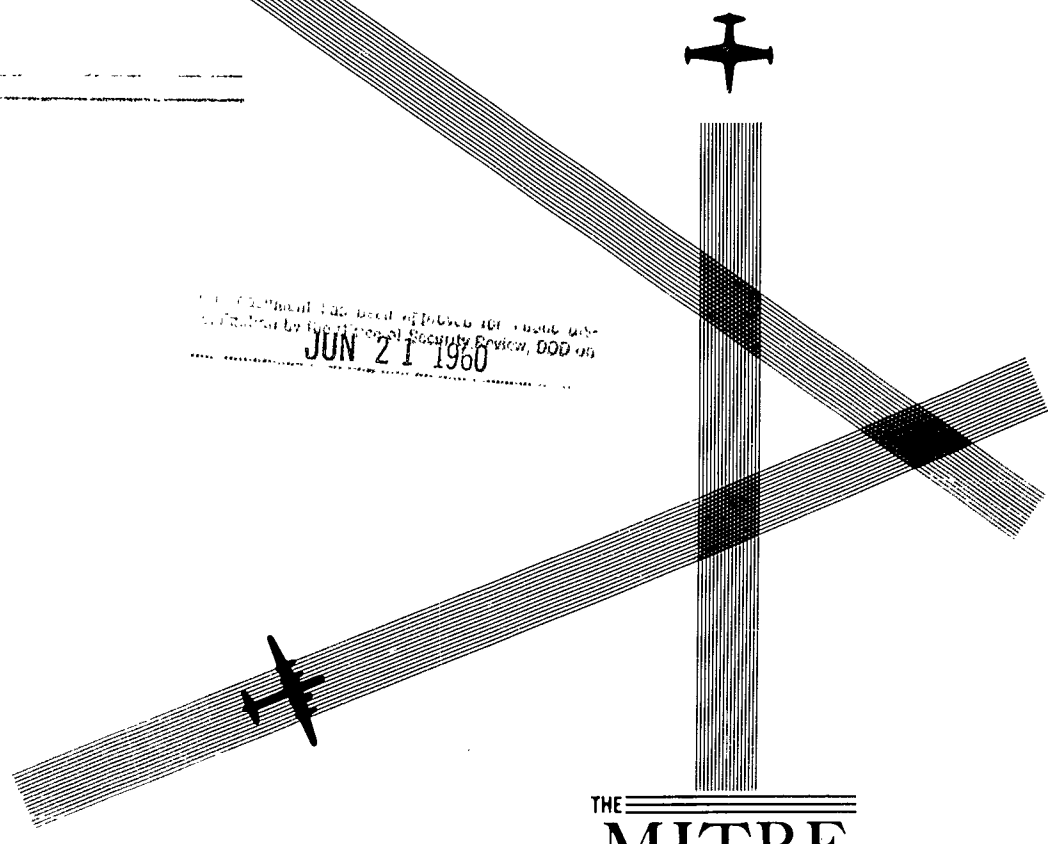
SR-10

ESTIMATED AIR TRAFFIC LOADS OVER AIR DIVISIONS IN THE YEARS 1960 TO 1975

by

W.COULOPOULOS
P.R.SIMONS
P.STYLOS
D.R.ISRAEL

ESD-TDR-63-391



THE MITRE CORPORATION

The research reported in this document was supported by the Department of the Air Force under Air Force Contract AF-33 (600) 39852.

ESTIMATED AIR TRAFFIC LOADS OVER AIR DIVISIONS IN THE YEARS 1960 TO 1975

by

W. D. COULOPOULOS (IBM), P. R. SIMONS, P. STYLOS, D. R. ISRAEL

ABSTRACT

Estimates of peak air traffic loads over air division areas were generated to aid in the design of an integrated air traffic control/air defense system. Basic data sources are Federal Aviation Agency IFR peak day measurements and the Curtis Report. This information was updated with recent traffic measurements and converted to obtain estimates of the number of instantaneous airborne aircraft during a peak hour of a peak VFR day for the years 1960, 1965, 1970, and 1975 with military, general aviation, and air carrier categories, divided into altitude strata below 15,000 feet, 15,000 to 24,000 feet, and above 24,000 feet. The hourly variation in traffic loads is presented and used to determine the number of airborne aircraft in each air division during periods of medium and low traffic activity on a peak VFR day in 1965.

1 October 1959

CONTENTS

CONTENTS (Cont.)

ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

The design of the integrated en route air traffic control/air defense system presently planned by the United States Air Force and the Federal Aviation Agency (FAA)* requires reasonable estimates of the future air traffic activity which such a system must handle. In particular, it is essential to know the numbers of airborne aircraft over each division area (see fig. 1) at a reasonably peak hour, for various altitude strata. This information is desired for the years 1960, 1965, 1970, and 1975 with a breakdown into the following flight categories (ref. 1B, p. 2):

Air carrier - scheduled passenger and air freight flights, and nonscheduled charter and contract flights, and nonrevenue testing and proficiency flights by all airlines;

Military - all flights by military aircraft, categorized as itinerant (transient) flights, in which aircraft depart from one airport and land at another, and local flights, in which aircraft depart from and return to the same airport (round-robin flights are classified as itinerant flights);

General aviation - all other flights (only itinerant flights are considered in this paper).

In the past, various surveys and estimates of air traffic activity have been made by the CAA (now FAA) and other research organizations to fulfill their specific needs. These reports have concentrated either on measures of air

---

*Refer to SR-6, "The Integration of Air Traffic Control and Air Defense," D. R. Israel, September 1959.

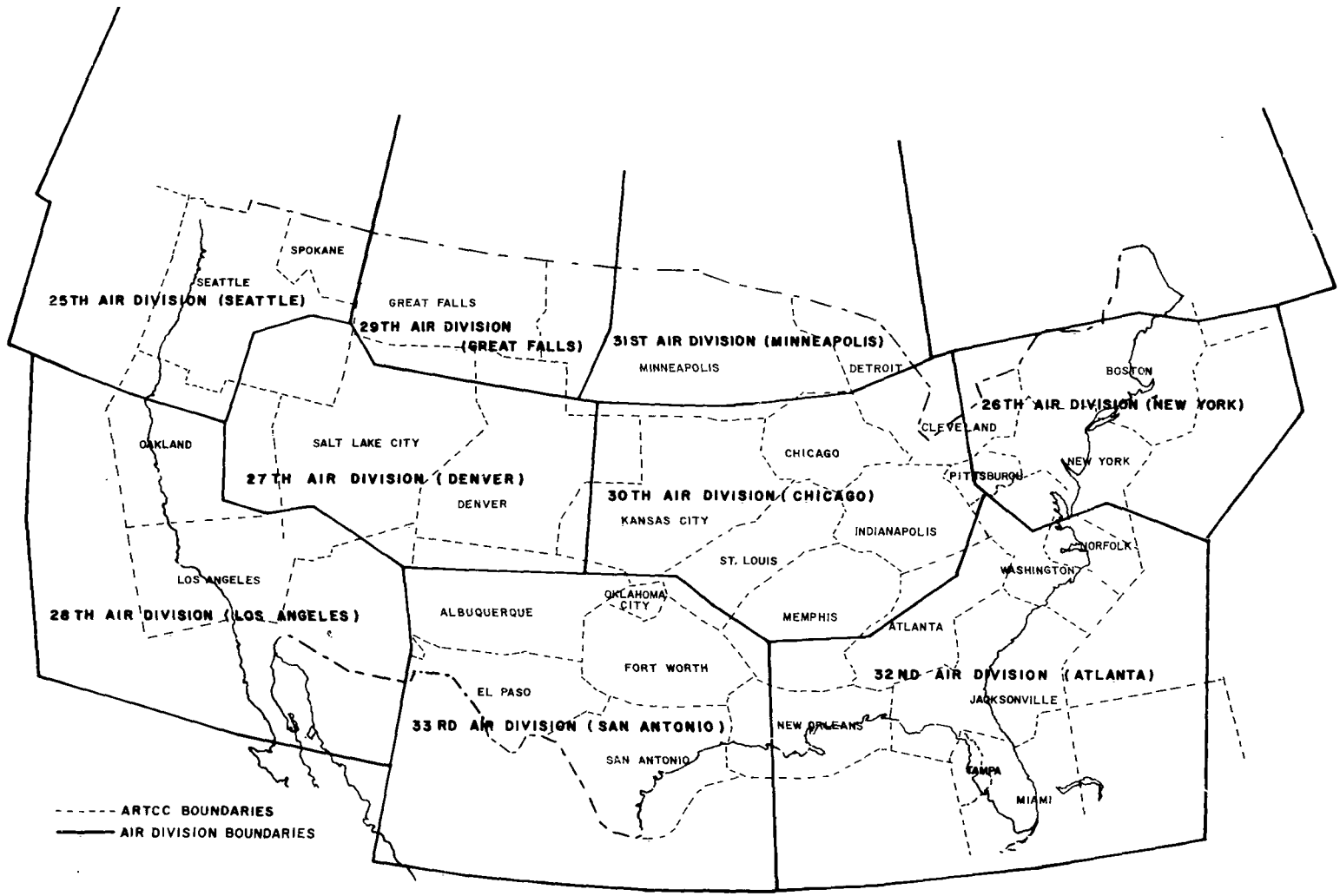


Fig. 1. A comparison of air route traffic control centers within air division boundaries

traffic activity not directly pertinent to the requirements outlined above, or have been directed towards geographical areas other than those shown in fig. 1. In addition, they are usually restricted to limited types of flying and do not contain altitude breakdowns or future growth trends.

The Bureau of Research and Development, FAA, is presently working on a comprehensive program (including present traffic surveys) to determine present and future air traffic activity. Since the full results of the FAA program will not be available for several months, this paper attempts to estimate the present and future air activity on the basis of current and usable survey data and associated reports (see appendix A). The results of this activity were first published as MITRE working papers W-365 and W-365, S1, "Forecast of Peak Air Traffic Loads Over Air Divisions, 1960-1975" (W. D. Coulopoulos and P. R. Simons, 14 August 1959 and 4 September 1959). These documents were distributed to interested organizations (including the FAA) for comments. These comments and several corrections to the data and methods have been incorporated in this report.

It is recognized that the methods used in deriving the final results are highly susceptible to certain basic assumptions (which are, insofar as possible, stated when used) and to errors in the various conversion factors, etc., employed. It is hoped that the errors counteract, and that the results are reasonably accurate. More significant figures are used than are justified.

CHAPTER 2

SUMMARY

IFR (instrument flight rules) peak day measurements and information from the references in appendix A were used to obtain estimates of the number of instantaneous airborne aircraft (air carrier, military, and general aviation) for the years 1960, 1965, 1970 and 1975, divided into altitude strata of 15,000 feet, 15,000 to 24,000 feet, and above 24,000 feet, and broken down into air division boundaries.

Estimates were also derived for the air traffic load over each air division during periods of medium and light air traffic activity on a peak VFR (visual flight rules) day in 1965. The year 1965 was selected because the integrated air traffic control/air defense system should be operational then, and the traffic above 24,000 feet, which will be the main concern of this common control system, will have become stabilized.

The results show the following significant features:

(a) Figures for total peak instantaneous nationwide airborne aircraft drop in 1965, then rise with substantial gains in general aviation and air carrier which offset the effects of a drop in military flying.

(b) Figures for air traffic above 24,000 feet also drop in 1965 and then remain relatively stable through 1975 when this category equals 15 per cent of the total all-altitude traffic. This is due, in part, to the decline in military flying and the corresponding increase in high altitude nonmilitary flying.

(c) The peak number of aircraft in flight above 24,000 feet in an air division in 1965 is 494 (71 per cent military local, 15 per cent

military transient, 13 per cent air carrier, 1 per cent general aviation). This peak number decreases to 469 and 447 in 1970 and 1975, respectively.

(d) Air traffic activity above 15,000 feet is expected to drop to a low in 1965 and rise steadily to 1975, when it will exceed 1960 figures and equal 35 per cent of the total all-altitude traffic.

(e) The concentration of instantaneous airborne traffic within air divisions, including all altitudes, varies from a low of less than 80 in the 29th (Great Falls) Air Division in 1960 to a little over 3,000 in the 30th (Chicago) Air Division in 1975.

(f) Five of the air divisions generally have a heavy traffic load; the other four air divisions have very light loads--only 10 to 15 per cent of the heavy loads.

(g) Each flight category peaks at a different time during the day. However, the total traffic in each air division peaks at the same hour (1400) whether the traffic is predominantly military, local, or general aviation.

(h) The hourly variation of traffic is quite similar for each air division. The shape of this variation curve approximates the shape of the hourly variation curve for military local traffic.

(i) Traffic in each air division during the day essentially consists of three levels of activity: busy, slow, and transition. The busy level occurs from about 0800 to 1700 (local time), when the traffic load is greater than 60 per cent of the peak value. This busy period includes a morning peak at 1000, a noon lull, and an afternoon peak at 1400, with the traffic at about 90, 80, and 100 per cent, respectively of the peak traffic for the day. The slow period occurs from about 2300 to 0600, when traffic is less than 10 per cent of peak. In the transition period there

is a rapid buildup from 0600 to 0800 (10 to 60 per cent of peak) and a gradual fall-off period from 1700 to 2300, when the traffic declines from about 60 to 10 per cent of peak.

(j) The hourly variation of the high altitude traffic is similar to that for all-altitude traffic, and the peak occurs at the same time. Military flights comprise the bulk of high altitude traffic during times of peak and medium traffic loads.

CHAPTER 3

OUTLINE OF GENERAL METHOD

References 1, 3, and 4 have been the most useful sources of information regarding present and future air traffic trends and altitude breakdowns. Valuable information concerning military flights and hourly activity was found in two other recent reports issued through the FAA (refs. 5 and 6).

Fig. 2 is a logical block diagram of the process used to develop the forecast data. Generally, the procedure is repeated for the three categories: air carrier, military itinerant, and general aviation. Since military local data was not available, it was later derived from the itinerant data, and in a sense is treated as a fourth category of flying.

It should be noted that in the determination of the portion of ARTCCs (air route traffic control centers) that will make up each air division, traffic density was considered as well as geographical area. It should also be noted that Canadian traffic within the air divisions and oceanic traffic flying over the United States were not considered. However, these omissions should not significantly affect the results.

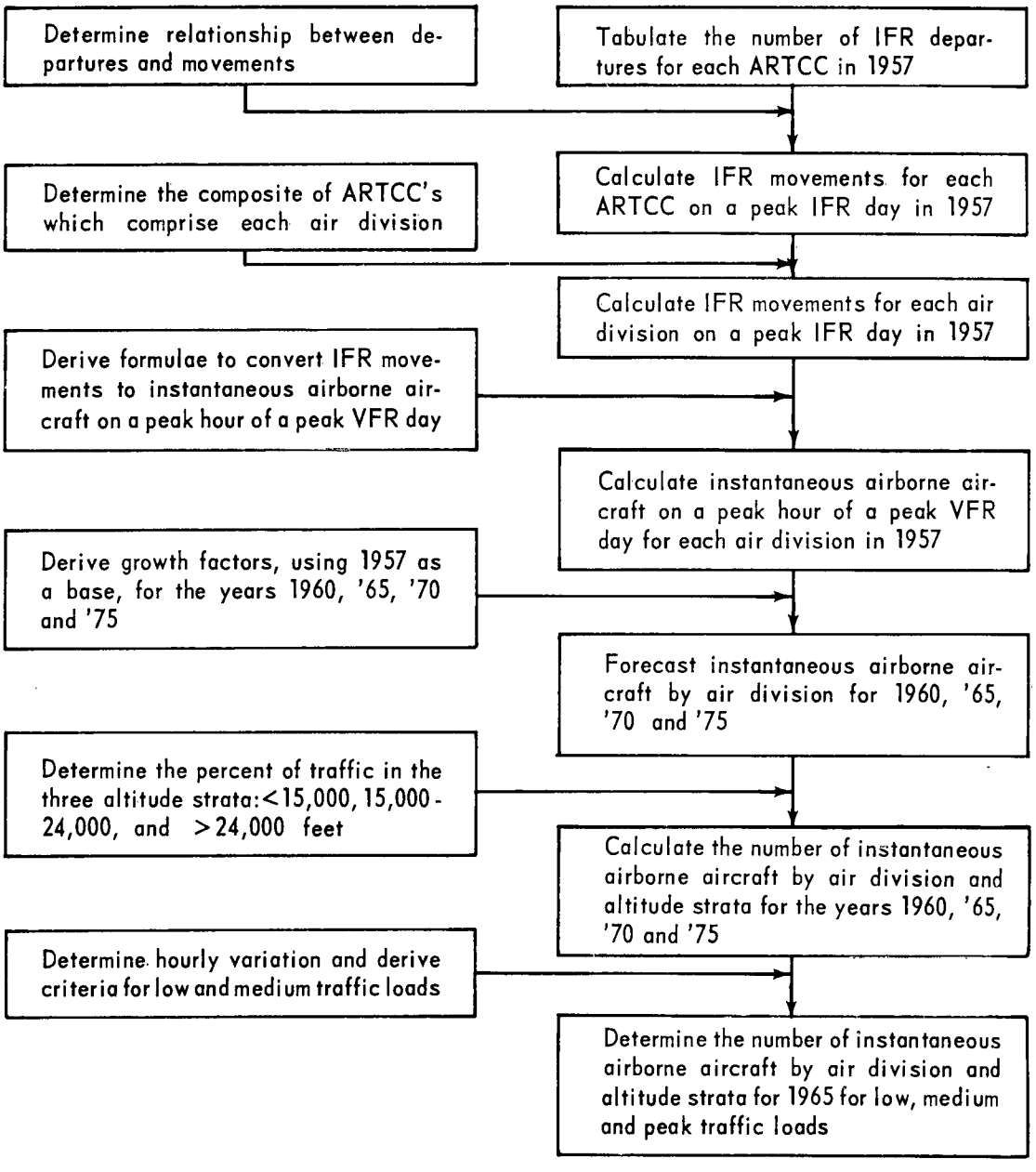


Fig. 2. Diagram of method used to generate forecast data

CHAPTER 4

DETERMINATION OF PRESENT TRAFFIC LOADS

The basic data used to determine present traffic loads is that given in the FAA (CAA) reports (refs. 3 and 4). The most useful and recent data obtainable in large volume concerned air traffic activity in 1957, and that year was selected as the base year for this report.

The FAA (CAA) reports are mainly concerned with the ARTCCs, the working control units of the nation-wide FAA air traffic control system (see fig. 1).

To utilize the information in these reports, it was necessary to carry out the following conversions:

(a) Center information to air division (sec. 4.1)

(b) Peak IFR departures to IFR movements (sec. 4.2)

(c) Peak IFR movements to instantaneous airborne aircraft on a peak hour of a busy VFR day (secs. 4.3, 4.4, 4.5, and 4.6)

4.1 METHOD OF APPORTIONMENT OF ARTCC TRAFFIC ALONG AIR DIVISIONS

For situations where the area of an ARTCC falls within more than one air division (see fig. 1), the results of the RAND report (ref. 7) were used to determine the apportionment of ARTCC traffic in each division.

The RAND report divides the continental United States into 2-degree latitude/longitude squares and calculates the traffic density (the average instantaneous number of airborne aircraft) in each square during a peak hour of an average day in August 1954. In using this information, it is assumed

that the distribution of traffic at the time of the RAND report (1954) remains unchanged in 1957. Furthermore, the traffic within a square is assumed to be uniformly distributed except in those cases in which the airway configuration and terminal locations indicate that this is not a reasonable assumption. In the latter situations, a distribution within a square is estimated in accordance with the traffic configuration.

The following procedure is then used to determine which portion of an ARTCC's traffic falls into a specific division:

(a) The total traffic in a center is determined by summing the traffic in each 2-degree square (and fractions thereof) within a center's area.

(b) Similarly, the traffic of a center which falls in a particular division is determined by summing the traffic in each 2-degree square (and fractions thereof) common to both the center and division under consideration.

(c) The ratio of the result of (b) to the result of (a) is the portion of the ARTCC's traffic which falls in the division being considered. This ratio is considered to exist in 1957 and is applied to the 1957 traffic figures to apportion a center's traffic among the divisions which share this traffic (sec. 4.2).

(d) The above steps are repeated for all combinations of centers and air divisions, and the results appear in fig. 3.

4.2 DERIVATION OF TOTAL MOVEMENTS WITHIN AIR DIVISION ON AN IFR PEAK DAY, 1957 FOR AIR CARRIER, MILITARY ITINERANT, AND GENERAL AVIATION

In this section the derivation (and references) refer to air carrier data. By substituting corresponding general aviation and military itinerant figures, the same equations can be utilized for all three categories:

D = The total departures on an IFR peak day in 1957 for each ARTCC (ref. 3)

AIR DIVISIONS

ARTCC	25th	26th	27th	28th	29th	30th	31st	32nd	33rd
Albuquerque			9.6	29.8					60.6
Atlanta						13.9		86.1	
Boston*		94.0							
Chicago						99.3	0.7		
Cleveland		29.2				70.8			
Denver			73.8		14.5	11.8			
Detroit						85.3	14.7		
El Paso				52.2					47.8
Fort Worth									100.0
Great Falls					100.0				
Indianapolis						100.0			
Jacksonville								100.0	
Kansas City			7.9			92.0			0.2
Los Angeles				100.0					
Memphis						59.6		22.7	13.1
Miami								100.0	
Minneapolis					11.5	4.6	83.9		
New Orleans								82.7	17.3
New York		100.0							
Norfolk		31.4						68.6	
Oakland	8.1		8.1	83.8					
Oklahoma City									100.0
Pittsburgh		67.9				32.1			
St Louis						77.6			22.4
Salt Lake City			73.9	16.8	9.3				
San Antonio									100.0
Seattle	87.3		12.7						
Tampa								100.0	
Washington		53.9				1.4		45.7	

*5.9% of the Boston ARTCC traffic falls in the Ottawa Air Division

Fig. 3. Percentage of ARTCC traffic in each air division

R = The ratio of 1957 annual air carrier departures to total annual departures for each ARTCC (ref. 4)

(DR) = Air carrier departures on an IFR peak day in 1957

2(DR) = M = Air carrier movements on an IFR peak day in 1957 for each ARTCC (the sum of departures and arrivals, assuming departures are equal to arrivals in one day)

P = The per cent of each ARTCC traffic by density within each air division boundary in 1954; it is assumed that there is no change in 1957 (see sec. 4.1)

(MP) = The air carrier movements on an IFR peak day, 1957, in the portion of an ARTCC within an air division

$\sum$ (MP) within an air division = The total air carrier movements on an IFR peak day, 1957, within the specified air division

Sample calculation for air carrier movements in the portion of the Atlanta ARTCC within the 32nd Air Division:

D = 669

$$R = \frac{112288}{162119} = .69$$

(RD) = 461.6

P = 86.1%

M = 923.2

(MP) = 795

Fig. 4 lists the total movements for each center in the 32nd Air Division, and fig. 5 lists the total movements for each air division.

	Per cent of ARTCC Traffic in Division	Air Carrier		General Aircraft		Military Itinerant	
		Departures	Movements in Portion of Center in Air Division	Departures	Movements in Portion of Center in Air Division	Departures	Movements in Portion of Center in Air Division
	P	RD	MP	RD	MP	RD	MP
Norfolk	68.6	42	57	5	7	95	130
Washington, D. C.	45.7	415	380	38	34	197	180
Atlanta	86.1	462	795	47	81	161	277
Miami	100.0	364	728	27	53	122	244
Jacksonville	100.0	185	371	29	57	246	492
New Orleans	82.7	237	391	23	37	264	436
Memphis	27.2	193	105	29	16	164	89
Tampa	100.0	104	207	7	14	53	107
Air Division			3,034		299		1,955

Fig. 4. Total IFR movements, peak day, 1957, for 32nd Air Division (Atlanta)

$$R = \frac{\text{1957 annual air carrier departures}}{\text{total annual departures for each ARTCC}}$$

D = air carrier departures

M = air carrier movements

Air Divisions	Air Carrier	General Aviation	M[illegible]
25th (Seattle)	411	25	317
26th (New York)	3,554	377	1,002
27th (Denver)	464	45	357
28th (Los Angeles)	1,215	129	1,258
29th (Great Falls)	193	22	92
30th (Chicago)	5,382	601	1,804
31st (Minneapolis)	553	80	113
32nd (Atlanta)	3,034	299	1,955
33rd (San Antonio)	1,489	264	1,942
	16,295	1,842	8,840

Fig. 5. Total IFR movements, peak day, 1957, for each air division

4.3 GENERAL FORMULAS FOR CONVERSION OF PEAK IFR DAY MOVEMENTS TO INSTANTANEOUS AIRBORNE AIRCRAFT ON A PEAK HOUR OF A PEAK VFR DAY

The formulas derived below are generally applicable to each type of flying: air carrier, military, and general aviation. Specific application to each type follows in secs. 4.4, 4.5, and 4.6.

M_c = Movements in the entire country during a peak IFR day

$\frac{M_c}{2} = F_c$ = Flights in the entire country during a peak IFR day (each flight consists of two movements: one departure and one arrival)

T_c = Countrywide average flight time (in hours)

$\frac{F_c T_c}{24}$ = Average instantaneous airborne aircraft throughout the country during a peak IFR day

$\frac{P}{A}$ = Ratio of peak instantaneous airborne aircraft to average instantaneous airborne aircraft during a peak hour

$\left(\frac{P}{A}\right)\left(\frac{F_c T_c}{24}\right)$ = Peak instantaneous airborne aircraft throughout country during a peak hour of peak IFR day

$\frac{M_d}{M_c}$ = Ratio of movements in an air division to movements in the entire country, peak IFR day

$\left(\frac{M_d}{M_c}\right)\left(\frac{P}{A}\right)\left(\frac{M_c}{2}\right)\left(\frac{T_c}{24}\right)$ = Peak instantaneous airborne aircraft in an air division during a peak hour of a peak IFR day (substitutes $\frac{M_c}{2}$ for F_c)

5% of total = The estimated value added to the total to account for over flights over an air division. *

C_f = The conversion factor applied to the total to convert from a peak hour of a peak IFR day to a peak hour of a peak VFR day

$\left(C_f\right)\left(\frac{P}{A}\right)\left(\frac{M_d}{2}\right)\left(\frac{T_c}{24}\right)$ x 1.05 = General formula for conversion of IFR peak day movements to instantaneous airborne aircraft on a peak hour of a peak VFR day

4.4 FACTORS TO BE APPLIED TO DERIVE INSTANTANEOUS AIRBORNE AIR CARRIER AIRCRAFT

The ratio of peak instantaneous airborne aircraft to average instantaneous aircraft, P/A, is taken as 1.53. The RAND report (ref. 7, p.93) implies that the peak conditions for air carrier is 6 per cent of the average conditions for the day; the average condition is equivalent to 1/24 of the peak or 4.2 per cent,

* This figure results from an analysis of the January 1959 air carrier schedules for the Atlanta Air Division and is assumed to apply to all air divisions.

resulting in a P/A of 1.44 for 1954. However, another source (ref. 5, p. 72) indicates that the P/A for 1958 may be derived by dividing the peak airborne air carrier aircraft (823) by total flights in the day (10, 300) multiplied by the average flying time per aircraft (1.25) divided by 24:

$$\frac{823}{[(10,300)(1.25)]\ /24} \quad \text{or } 1.53$$

The average flight time, T_c, is 1.25 hours (ref. 5, p. 22); air carrier movements per division, M_d, are found in fig. 5; the conversion factor, C_f, is 1.27 (ref. 9, p. 2). Results are shown in fig. 7.

4.5 FACTORS TO BE APPLIED TO DERIVE INSTANTANEOUS AIRBORNE ITINERANT AND LOCAL MILITARY AIRCRAFT

4.5.1 Military Itinerant

The ratio of peak hour to average hour, P/A (9/4.2), is 2.2. The peak conditions for military itinerant is 9 per cent of the average conditions for the day (ref. 7, p. 93). The average flight time, T_c, is 2.5 hours (ref. 5, p. 22); military itinerant movements per division, M_d, are given in fig. 5; the conversion factor C_f is 1.30 (ref. 9, p. 2).

4.5.2 Military Local

By using the 2-degree square method (described in sec. 4.1), a ratio of average instantaneous airborne military local aircraft to average instantaneous airborne military transient aircraft for each division was derived (fig. 6). Results for military itinerant and military local flights are shown in fig. 7.

4.6 FACTORS TO BE APPLIED TO DERIVE INSTANTANEOUS AIRBORNE GENERAL AVIATION AIRCRAFT

The ratio of peak hour to average hour, P/A, is 3.0 (ref. 1B, p. 171, fig. 63). The average flight time, T_c, is 1.3 hours (ref. 1D, p. 84); general aviation movements per division, M_d, are found in fig. 5; the conversion factor, C_f, is 15.0 (ref. 9, p. 2). The results are shown in fig. 7.

25th	(Seattle)	2.52
26th	(New York)	2.65
27th	(Denver)	0.53
28th	(Los Angeles)	3.90
29th	(Great Falls)	1.02
30th	(Chicago)	1.64
31st	(Minneapolis)	1.77
32nd	(Atlanta)	4.62
33rd	(San Antonio)	3.03

Fig. 6. Factors to convert military itinerant aircraft to military local instantaneous airborne aircraft

				Military	
		Air Carrier	General	Local	Itinerant
25th	(Seattle)	22	32	133	53
26th	(New York)	190	486	442	167
27th	(Denver)	25	58	32	59
28th	(Los Angeles)	65	166	817	209
29th	(Great Falls)	10	28	16	15
30th	(Chicago)	288	775	492	300
31st	(Minneapolis)	30	103	33	19
32nd	(Atlanta)	163	386	1,502	325
33rd	(San Antonio)	80	341	978	323
		873	2,375	4,445	1,470

Fig. 7. Instantaneous airborne aircraft, peak hour of a peak VFR day, 1957

CHAPTER 5

DETERMINATION OF GROWTH FACTORS

The growth factors for air carrier, military, and general aviation movements are determined by comparing the estimated annual movements for each category as obtained from ref. 1. The results are presented in fig. 8.

	Air Carrier	General Aviation	Military (Itinerant and Local)
1957	1.00	1.00	1.00
1960	1.03	1.22	1.02
1965	1.43	1.62	0.78
1970	1.51	2.16	0.68
1975	2.00	2.66	0.57

Fig. 8. Growth factors

5.1 AIR CARRIER

The estimated air carrier movements for the years 1955, 1960, 1965, 1970, and 1975 are obtained from ref. 1D, p.43, table 2.14. The figure for 1957 is obtained by linear interpolation between the values for 1955 and 1960. The growth for each of these years is then computed using 1957 as the base year.

5.2 MILITARY

The growth factors for military movements are determined from data available in ref. 1C, part II. The programmed flying hours in the continental

United States for the years 1956, 1960, 1965, and 1975 are given in ref. 1C, p. 29, and the estimated number of annual movements for 1956 and 1975 appears in ref. 1C, pp. 2 and 3. The movement-to-flying hour ratios for 1956 and 1975 are 1.73 and 1.69, respectively. The number of annual movements for 1960 and 1965 is determined by using a movement-to-flying hour ratio of 1.71, and the values for 1957 and 1970 are obtained by linear interpolation. The growth figures apply equally to both military itinerant and military local, since ref. 1C estimates that the breakdown between these two activities will remain essentially unchanged.

5.3 GENERAL AVIATION

The estimated annual itinerant movements for the years 1955, 1960, 1965, 1970, and 1975 are obtained from ref. 1D, p. 140, tables 10 and 11. The movements for 1957 are obtained by linear interpolation between the 1955 and 1960 figures.

CHAPTER 6

ESTIMATED ALTITUDE DISTRIBUTION

6.1 AIR CARRIER TRAFFIC, 1960-75

6.1.1 General

While the primary objective is to forecast the air traffic at altitudes greater than 24,000 feet, three altitude strata were used in this study: less than 15,000 feet, 15,000 to 24,000 feet, and greater than 24,000 feet.

The method used in making these estimates is similar, in part, to that used in ref. 1 for estimates of air carrier movements for the same years. Essentially, it consists of converting the ref. 1 estimates of revenue passenger miles for various trip lengths for these years to departures by trip length and transport type for the same periods. These departures are then assumed to be distributed among the three altitude strata depending upon the transport type and trip length involved. The relationship between departures and flight time is then determined by trip length and transport type. The total flight time in each altitude strata is then determined. The distribution of total flying time among the three altitude strata is then determined for each year of interest.

In the discussion that follows, small, medium, and large transports are defined as transports which can carry 50 or fewer passengers, 51 to 100 passengers, and over 100 passengers, respectively (ref. 1A, p. 13). Three groupings of trip length are considered: 0 to 500 miles, 501 to 1,000 miles, and greater than 1,000 miles (ref. 1). A trip may consist of more than one stage (one or more intermediate stops).

6.1.2 Departures by Transport Type and Trip Length, 1960-75

The revenue passenger miles for each combination of transport class, trip length, and year are converted to departure as follows:

$$\text{Number of departures} = \frac{\text{revenue passenger miles}}{(\text{average passenger load})\ (\text{average stage length})}.$$

The revenue passenger miles by trip length for 1960 to 1975 are assumed to be the average of the high and low estimate given in ref. 1D, p. 41, table 2.10. These averages are tabulated in fig. 9. The revenue passenger miles are assumed to be distributed among the three transport classes (small, medium, large) for the years 1960 to 1975 as estimated in ref. 1D, p.42, table 2.11. These miles are shown in fig. 10.

Trip Length	1960	1965	1970	1975
0-500 miles	7.33	10.72	15.07	20.73
501-1000 miles	7.24	11.16	15.18	18.32
Over 1000 miles	15.86	20.07	24.38	29.40

Fig. 9. Revenue passenger miles (billions) by trip length, 1960-75

Type of Aircraft	0-500 Miles				501-1000 Miles				Over 1000 Miles			
	1960	1965	1970	1975	1960	1965	1970	1975	1960	1965	1970	1975
Small	48	48	16	16	—	—	—	—	—	—	—	—
Medium	52	52	69	69	75	75	25	25	25	25	—	—
Large	—	—	15	15	25	25	75	75	75	75	100	100
	100	100	100	100	100	100	100	100	100	100	100	100

Fig. 10. Per cent of revenue passenger miles flown by each transport class, 1960-75

The average passenger load for each transport class is determined from the following equation:

Average passenger load = (number of coach seats) (per cent passengers traveling coach) + (number of first class seats) (per cent passengers traveling first class) (load factor)

The estimates of the seating capacity for each transport class, both in the coach and first class configuration, and the per cent of passengers traveling by coach for the years 1960-75 are obtained from ref. 1D, p. 65. A load factor of 60 per cent is assumed for all years. The calculated passenger loads by transport class and year are listed in fig. 11.

Transport Type	1960	1965	1970	1975
Small	24	24	24	24
Medium	47	48	51	52
Large	70	74	78	82

Fig. 11. Passenger loads by transport class

The average flight stage length is considered to be 40 per cent of the average length of the passenger journey, and that is considered to be the midpoint of the trip length grouping (250 miles, 750 miles, and 1, 500 miles, respectively for the three trip lengths) (ref. 1D, p. 42). Consequently the average flight stage length is 100 miles, 300 miles, and 600 miles, respectively for the three trip length groupings. The resultant departures by transport class, trip length, and year are tabulated in fig. 12.

The total departures for each transport class by year are then distributed among the transport types (piston, turboprop, and turbojet) within that class

Transport Class	Total	0-500 Miles	501-1,000 Miles	Over 1,000 Miles
1960				
Small	1,465	1,465	—	—
Medium	1,336	811	385	140
Large	370	—	87	283
1965				
Small	2,145	2,145	—	—
Medium	1,903	1,152	578	173
Large	465	—	126	339
1970				
Small	1,050	1,050	—	—
Medium	2,294	2,045	249	—
Large	1,300	290	488	522
1975				
Small	1,380	1,380	—	—
Medium	3,044	2,750	294	—
Large	1,539	380	560	599

Fig. 12. Departures (thousand) by transport class and trip length

according to the fleet composition shown in fig. 13. Examples of aircraft within each transport type are included in fig. 14. The fleet composition for the years 1965, 1970, and 1975 are obtained from ref. 1C, part I, p. 39. The figures for 1960 are determined from the air carrier fleet composition as of January 1959 to which the aircraft on order for delivery in 1959 and 1960 were added. These figures are obtained from ref. 10. The resulting total departures by transport type and year are included as the first column of fig. 15. The total departures by transport type in each year are then distributed among the various trip length groups.

Transport Type	1960* Per Cent of Total Fleet	1960* Per Cent of Transport Class	1965** Per Cent of Total Fleet	1965** Per Cent of Transport Class	1970** Per Cent of Total Fleet	1970** Per Cent of Transport Class	1975** Per Cent of Total Fleet	1975** Per Cent of Transport Class
Small:								
Piston	38	86	20.5	50	14	47	9	43
Turboprop	5	14	20.5	50	16	53	12	57
		100		100		100		100
Medium:								
Piston	40	85	9	20	5	10	4	8
Turboprop	6	11	24	55	28	61	28	63
Turbojet	2	4	11	25	14	29	13	29
		100		100		100		100
Large:								
Turbojet	9	100	15	100	23	100	34	100
	100		100		100		100	

Fig. 13. Fleet composition by transport type

* Reference 10, (Page 121)
** Reference 1C, Part 1, Page 39

In order to do this, the following assumptions were made for each of the years considered.

1960

(a) Medium turboprops are not used on trips exceeding 1,000 miles.

(b) Medium turbojets are not used on trips under 500 miles.

(c) The departures in the medium transport class in the 501 to 1,000-mile trip category are distributed among the types within this class in the same proportion as the medium transport class fleet composition in this year.

1965

(a) Medium turboprops are not used on trips exceeding 1,000 miles.

(b) Medium turbojets are not used on trips under 500 miles.

(c) Medium pistons are not used on trips exceeding 500 miles.

1970 and 1975

(a) Medium pistons are not used on trips exceeding 500 miles.

(b) The distribution of departures in the medium transport class on trips of less than 500 miles is similar to the medium transport fleet composition in the year being considered

Small Piston:	DC-3, DC-4, Convair and Martin series
Small Turboprop:	Viscount, Fairchild F-27, Convair 540
Medium Piston:	DC-6 and DC-7 series, Constellation series, Stratocruiser
Medium Turboprop:	Electra, Vickers Vanguard, Bristol Brittania
Medium Turbojet:	DC-9, Convair 880, Comet IV, Caravelle
Large Turbojet:	DC-8, Boeing 707

Fig. 14. Examples of transport types*

*Reference 1C, Part 1, Pages 3 and 4

Departures (Thousands)

Transport Type	Total	0-500 Miles	501-1,000 Miles	Over 1,000 Miles
1960				
Small				
Piston	1,260	1,260		
Turboprop	205	205		
Medium				
Piston	1,136	706	327	102
Turboprop	147	105	42	
Turbojet	53		15	38
Large				
Turbojet	370		87	283
1965				
Small				
Piston	1,073	1,073		
Turboprop	1,073	1,073		
Medium				
Piston	381	381		
Turboprop	1,047	771	276	
Turbojet	475		302	173
Large				
Turbojet	465		126	339
1970				
Small				
Piston	494	494		
Turboprop	557	557		
Medium				
Piston	229	229		
Turboprop	1,400	1,249	151	
Turbojet	665	567	98	
Large				
Turbojet	1,300	290	488	522
1975				
Small				
Piston	593	593		
Turboprop	787	787		
Medium				
Piston	244	244		
Turboprop	1,916	1,730	186	
Turbojet	884	776	108	
Large				
Turbojet	1,539	380	560	599

Fig. 15. Departures by transport type and trip length, 1960-75

6.1.3 Altitude Distribution

The air carrier altitude distribution by transport type and trip length is assumed to be as shown in fig. 16. Each transport type is distributed among the three altitude classes depending on trip length. For example, it is assumed that all medium piston transports flying on trips shorter than 500 miles remain below 15,000 feet, while all those flying on trips longer than 1,000 miles fly between 15,000 and 24,000 feet. The altitude distributions, shown in fig. 16, are assumed to hold true throughout the forecast period.

The departures for each transport type and trip length (fig. 15) are then altitude-distributed according to the assumed distribution (fig. 16) in order to determine the number of departures in each altitude class for each combination of transport type and trip length. The average flying time for each departure (or flight) is then determined by dividing the average stage length of the flight by the average cruising speed of the transport type making the flight. (The average cruising speed for each transport type is shown in fig. 17). The total flying time within an altitude class is then determined by summing the individual flying times for all flights within that altitude class. The distribution of flying time within the three altitude classes is assumed to represent the distribution of instantaneous airborne air carrier aircraft within these altitude classes. The results are presented in fig. 18. The slight decline in the per cent of air carrier traffic above 24,000 feet in 1975 results from the fact that traffic at lower altitudes will increase faster than traffic above 24,000 feet during the period from 1970 to 1975.

6.2 MILITARY TRAFFIC, 1960-75

The present altitude breakdown for all military aircraft (itinerant and local percentages are the same) derived from total aircraft flown (jet, propeller,

Per Cent of Air Carrier Aircraft Departures

	0–500 Miles			501–1,000 Miles			Over 1,000 Miles		
Transport Type	<15,000	15–24,000	>24,000	<15,000	15–24,000	>24,000	<15,000	15–24,000	>24,000
Small Piston	100								
Small Turboprop	50	50							
Medium Piston	100			50	50			100	
Medium Turboprop	50	50		10	80	10			
Medium Turbojet	20	80			70	30		20	80
Large Turbojet		100			50	50		20	80

Fig. 16. Air carrier altitude (feet) distribution by transport type and trip length

Type	Average Cruising Speed (Knots)			
	1960*	1965	1970*	1975
Small Piston	250	250	275	275
Small Turboprop	300	300	300	300
Medium Piston	250	250	250	250
Medium Turboprop	350	350	350	350
Medium Turbojet	500	500	500	500
Large Turbojet	490	490	525	525

Fig. 17. Cruising speeds of air carrier aircraft** (knots)

* The average 1960 cruising speeds are assumed to be the same as those for 1965; those for 1970 are assumed to be the same as those for 1975.

** Reference 1A, Table 7, page 12 midpoint of range of cruising speeds.

Altitude Range (Feet)	Per Cent of Airborne Air Carrier Aircraft			
	1960	1965	1970	1975
Less than 15,000	52	39	28	29
15,000–23,900	31	34	40	42
24,000 and above	17	27	32	29
	100	100	100	100

Fig. 18. Altitude distribution of airborne air carriers, 1960–75

helicopter, and airship) by the Army, Navy, and Air Force (ref. 5, p. 20 and ref. 6, p.16) is:

(a) 57 per cent below 15,000 feet;
(b) 13 per cent between 15,000 and 24,000 feet;
(c) 30 per cent above 24,000 feet.

It is assumed that in the future the number of military aircraft will decrease, while the flying missions will remain essentially the same. Although the performance capability of the aircraft will increase with time, the usage of altitude strata (per cent of total) will probably remain the same as the present for the years 1960-75.

6.3 GENERAL AVIATION TRAFFIC, 1960-75

The per cent of general aviation fleet by type for the years 1955 to 1975 was calculated (fig. 19) by linear interpolation (ref. 1D, p. 12, table 6).

Aircraft Type	1955	1960	1965	1970	1975
Light Single	61.8	50.3	37.2	26.1	13.8
Heavy Single	32.6	41.0	50.0	58.0	66.7
Light Twin	5.0	8.0	12.0	15.0	18.6
Transport	.6	.7	.8	.9	.9
	100.0	100.0	100.0	100.0	100.0

Fig. 19. Per cent of general aviation fleet by type, 1955-75

An analysis of cruising altitudes shown in ref. 1D, table 6 and an application of the figures in fig. 19 yielded an estimated altitude distribution for the general aviation fleet in the years 1955 to 1975 (fig. 20).

Altitude in Thousands of Feet	1955	1960	1965	1970	1975
0-15	99.5	96.0	91.5	85.0	80.0
15-24	.5	4.0	8.0	13.0	16.0
24+	--	--	.5	2.0	4.0

Fig. 20. Per cent of estimated altitude distribution for general aviation, 1955-75

CHAPTER 7

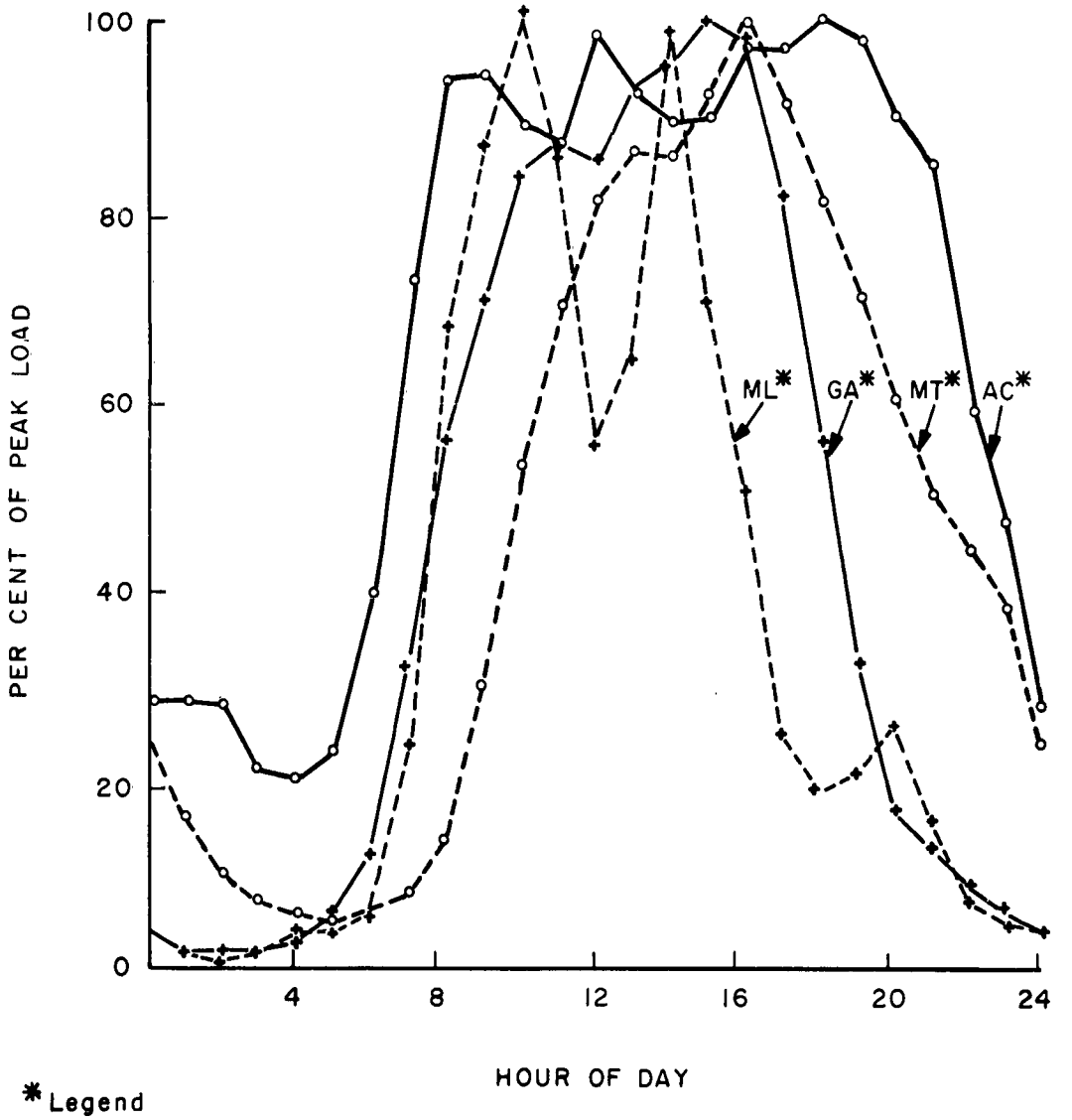
HOURLY VARIATION OF AIR TRAFFIC

7.1 AIR CARRIER

The hourly variation of air carrier traffic, in terms of peak hour activity, was obtained by adjusting the data in ref. 7, table 11, so that the peak hour for air carrier traffic was the base hour of the distribution. Fig. 21 shows air carrier traffic to be relatively uniform between 0800 and 2100 (at least 80 per cent of the peak traffic during this entire period). Traffic experiences a sharp buildup from an early morning (approximately 0400) low to a morning peak at 0800 which is about 94 per cent of the peak hour traffic at 1800. It then remains relatively uniform between 0800 and 2100, ranging between 85 per cent and 100 per cent of peak hour traffic. Traffic then falls off rapidly, remaining below 30 per cent of peak hour traffic from 2100 until it starts its early morning buildup the next day.

7.2 MILITARY ITINERANT

The hourly variation of military itinerant traffic, in terms of peak hour activity, was obtained from ref. 5, p. 15. Peak hour traffic was considered to have a value of 1.00 and traffic at other hours of the day was computed relative to peak hour traffic. Military itinerant traffic starts from an early morning low at 0400 and builds up gradually until the daily peak is reached at 1600. It then experiences a sharp decline, becoming less than 25 per cent of the peak by 2000.



*Legend
AC - Air Carrier
GA - General Aviation
MI - Military Itinerant
ML - Military Local

Fig. 21. Hourly variation of aircraft in flight

7.3 MILITARY LOCAL

The hourly variation of military local traffic was obtained in a manner similar to military itinerant traffic. The data source was ref. 6, p. 24. Military local traffic experiences a very rapid buildup from 6 to 100 per cent of the peak for the day between 0600 and 1000. Traffic then dips at noon to about 56 per cent of the morning peak and again builds up rapidly to an afternoon peak at 1400, at which time traffic is about 99 per cent of the morning peak. The amount of traffic then declines rapidly until it is less than 30 per cent of the peak by 1700.

7.4 GENERAL AVIATION

The variation of general aviation traffic in terms of peak hour activity was obtained by adjusting the data in ref. 7, table 11, so that the peak hour for general aviation traffic was the base hour of the distribution. General aviation traffic gradually builds up from its daily low in the early morning hours until it reaches a peak at 1500 after which it declines quite rapidly.

CHAPTER 8

DETERMINATION OF THE TIME AT WHICH MEDIUM AND LOW TRAFFIC ACTIVITY OCCURS

Fig. 21 shows that each category of flying reaches a peak at a different hour of the day. Therefore, it is necessary to determine the variation of all traffic throughout the day in order to select the time of day when low, medium, and peak traffic activity will occur.

8.1 HOURLY VARIATION OF TRAFFIC IN THE 32ND (ATLANTA) AIR DIVISION ON A PEAK VFR DAY, 1965

The hourly variation of air traffic for each traffic category on a peak VFR day in 1965 in the Atlanta Air Division is described below:

(a) The peak air traffic by category on a peak VFR day in 1965 was obtained from fig. 30.

(b) Each category was distributed as shown in fig. 21, using the peak traffic figure in (a) above.

(c) The total traffic for each hour was obtained by combining the results of (b) above for each category for that hour.

(d) The results for each hour were plotted in fig. 22.

The above procedure was repeated only for the high altitude traffic (above 24,000 feet) in the Atlanta Air Division.

Fig. 22 shows that the shape of the hourly traffic distribution curve for all-altitude traffic is similar to that for high altitude traffic with both peaking at 1400 hours. In addition, both distributions are very similar to those shown for military local flights in fig. 21. This is readily explained by the fact that

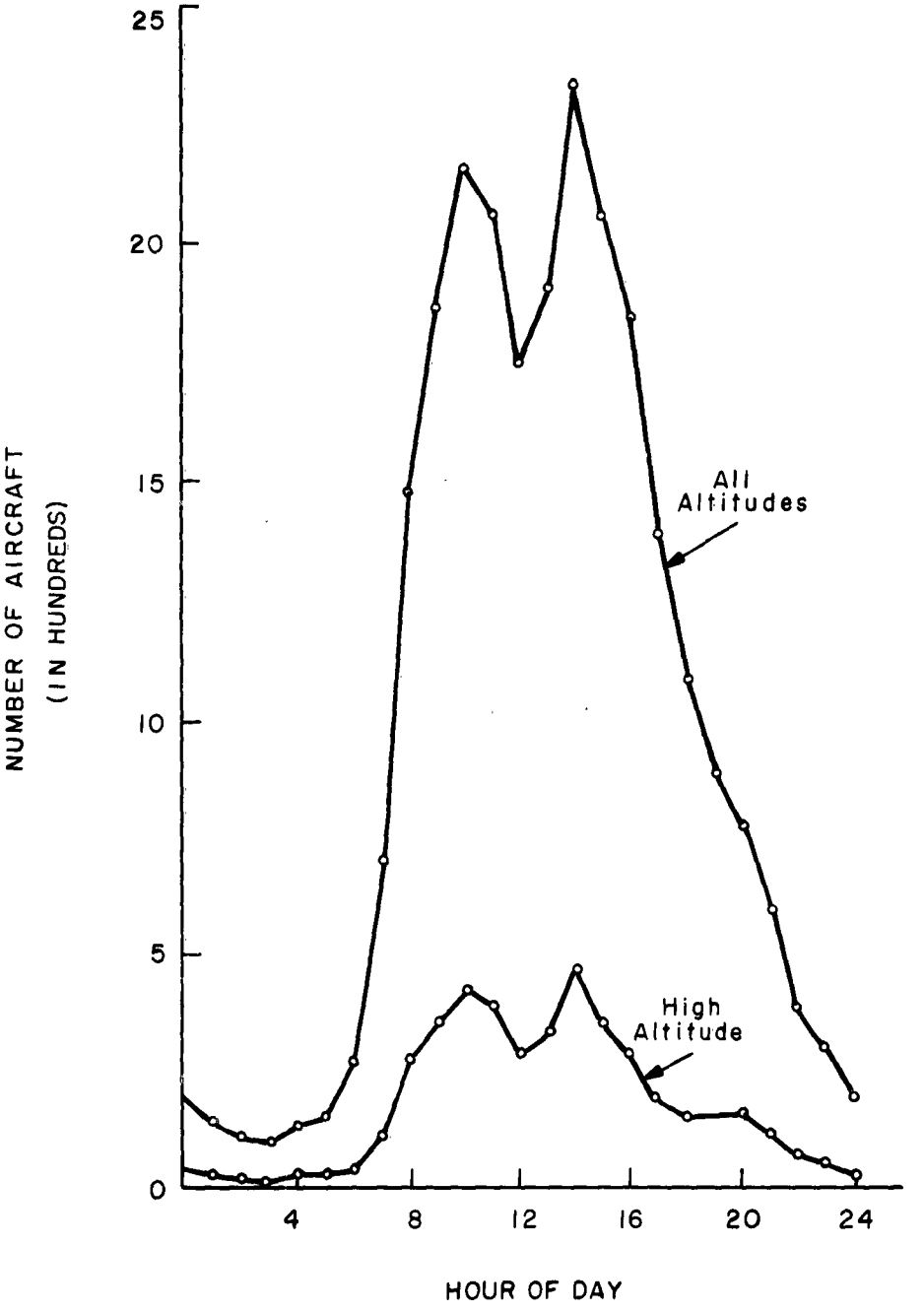


Fig. 22. Hourly variation of aircraft in flight, 32nd Air Division (Atlanta) peak VFR day, 1965

traffic in the Atlanta Air Division is predominantly of the military local category, (48 per cent of the total traffic and 77 per cent of the high altitude traffic).

8.2 HOURLY TRAFFIC VARIATION IN OTHER AIR DIVISIONS WITH HEAVY TRAFFIC LOADS ON A PEAK VFR DAY, 1965

The procedures of sec. 8.1 were repeated to compare the hourly variation of traffic in the Atlanta Air Division with other air divisions for both all-altitude and high altitude traffic.

8.2.1 All-Altitude Traffic

Since air traffic in the Atlanta Air Division is predominantly military local flying, the procedures of sec. 8.1 were repeated for the Chicago Air Division, which was selected for this comparison because its total air traffic is predominantly in the general aviation category (63 per cent of the total air traffic). The shape of the hourly distribution curve of all-altitude traffic was found to be similar to that of the Atlanta Air Division. In both cases the peak occurred at 1400. The hourly variation of all-altitude traffic in the Atlanta Air Division is assumed to be representative of all other air divisions, since the all-altitude air traffic in the other air divisions principally consists of either military local or general aviation flights.

8.2.2 High-Altitude Traffic

The largest portion of high altitude traffic (above 24,000 feet) in all air divisions is military local flights. Therefore, the hourly variation of high altitude traffic in the Atlanta Air Division is representative of that traffic in other air divisions.

8.3 TIME OF PEAK, MEDIUM, AND LOW TRAFFIC ACTIVITY

8.3.1 Peak Traffic Activity

Since the hourly variation of air traffic in all heavy and medium traffic air divisions is similar to that shown in fig. 22 for the Atlanta Air Division, the peak hour for both all-altitude and high altitude traffic is 1400.

8.3.2 Medium Traffic Activity

Medium traffic activity is considered to occur when the traffic is about 50 per cent of peak hour traffic. A representative hour would be 1900.

8.3.3 Low Traffic Activity

Low traffic activity is defined as less than 10 per cent of the peak hour traffic. The hour selected for low traffic activity is 0500 since the traffic activity at this time is about halfway between the daily low and the 10 per cent mark for both all-altitude and high altitude traffic.

CHAPTER 9

RESULTS

9.1 BASIC DATA

The basic data resulting from this study is shown in figs. 23 through 31. They include the number of instantaneous airborne aircraft during a peak hour of a peak VFR day for each air division and a breakdown by altitude and category for the years 1960 to 1975.

Fig. 32 shows the low, peak, and medium figures of the estimated aircraft in flight on a peak VFR day for each air division in 1965. The peak traffic load was obtained from figs. 23 through 31. The medium and low traffic load is obtained by taking the following percentages of the peak load:

Type of Flying	Medium Load Per Cent of Peak	Low Load Per Cent of Peak
Air carrier	100	23
Military itinerant	71	5
Military local	21	4
General aviation	32	6

9.2 ANALYZED DATA

Fig. 33 shows the estimated instantaneous airborne aircraft nationwide during a peak hour of a peak VFR day, 1960 to 1975. The estimated dip in total aircraft between 1960 and 1975 can be explained by a sharp decline in military flying. Beyond 1965, the less radical decline of total military aircraft is compensated by substantial general aviation and moderate air carrier gains.

Fig. 34 shows the estimated distribution of the total nationwide aircraft in flight above 15,000 and 24,000 feet, 1960 to 1975. Traffic above 24,000 feet is expected to decrease, reaching a low in 1965 which will remain relatively stable through 1975. This again is due to the decline of military flying before the increase in higher altitude nonmilitary flying. The total aircraft in flight above 15,000 feet is also expected to decrease to its low in 1965 and then increase steadily to 1975.

Fig. 35 shows the estimated usage by type and total aircraft of the altitude strata 15,000 to 24,000 and above 24,000 feet for the years 1960 to 1975. Military usage of these altitudes is shown in a definite decline. Air carrier and general aviation indicate a significant rise in the 15,000 to 24,000 feet category, but rise only slightly in the above 24,000 feet category beyond 1960.

Figs. 36, 37, and 38 present a more detailed breakdown of total flying activity by air division, altitude, and year. In 1975, 35 per cent of the estimated total nationwide aircraft in flight will be above 15,000 feet, with 15 per cent above 24,000 feet. The 30th (Chicago) Air Division will carry the greatest traffic load after 1960, while the 32nd (Atlanta) Air Division will carry the largest traffic over 15,000 and over 24,000 feet, 1960 to 1975. The 29th (Great Falls) Air Division is estimated to have approximately 1 per cent of the total in-flight nationwide traffic at all altitudes and less than 1 per cent of that above 24,000 feet in the years 1960 to 1975.

Year	Type	<15,000	15,000-24,000	>24,000	Total
1960	Air Carrier	12	7	4	23
	Military Itinerant	31	7	16	54
	Military Local	77	18	41	136
	General Aviation	37	2	0	39
	Total	157	34	61	252
1965	Air Carrier	12	11	8	31
	Military Itinerant	24	5	12	41
	Military Local	59	14	31	104
	General Aviation	48	4	0	52
	Total	143	34	51	228
1970	Air Carrier	9	13	11	33
	Military Itinerant	20	5	11	36
	Military Local	52	12	27	91
	General Aviation	59	9	1	69
	Total	140	39	50	229
1975	Air Carrier	13	18	13	44
	Military Itinerant	17	4	9	30
	Military Local	43	10	23	76
	General Aviation	68	14	3	85
	Total	141	46	48	235

Fig. 23. Estimated instantaneous airborne aircraft, 25th (Seattle) Air Division, by type and altitude strata (peak hour of a peak VFR day) 1960-75

Year	Type	<15,000	15,000-24,000	>24,000	Total
1960	Air Carrier	102	61	33	196
	Military Itinerant	97	22	51	170
	Military Local	256	59	135	450
	General Aviation	569	24	0	593
	Total	1,024	166	219	1,409
1965	Air Carrier	106	92	74	272
	Military Itinerant	74	17	39	130
	Military Local	196	45	103	344
	General Aviation	720	63	4	787
	Total	1,096	217	220	1,533
1970	Air Carrier	80	115	92	287
	Military Itinerant	64	15	34	113
	Military Local	171	39	90	300
	General Aviation	893	136	21	1,050
	Total	1,208	305	237	1,750
1975	Air Carrier	110	160	110	380
	Military Itinerant	54	12	28	94
	Military Local	144	33	76	253
	General Aviation	1,034	207	52	1,293
	Total	1,342	412	266	2,020

Fig. 24. Estimated instantaneous airborne aircraft, 26th (New York) Air Division, by type and altitude strata (peak hour of a peak VFR day) 1960-75

Year	Type	<15,000	15,000-24,000	>24,000	Total
1960	Air Carrier	14	8	4	26
	Military Itinerant	35	8	18	61
	Military Local	18	4	10	32
	General Aviation	68	3	0	71
	Total	135	23	32	190
1965	Air Carrier	14	12	10	36
	Military Itinerant	27	6	14	47
	Military Local	14	3	7	24
	General Aviation	86	8	0	94
	Total	141	29	31	201
1970	Air Carrier	11	15	12	38
	Military Itinerant	23	5	12	40
	Military Local	12	3	6	21
	General Aviation	106	16	3	125
	Total	152	39	33	224
1975	Air Carrier	15	21	14	50
	Military Itinerant	20	5	10	35
	Military Local	10	2	6	18
	General Aviation	123	25	6	154
	Total	168	53	36	257

Fig. 25. Estimated instantaneous airborne aircraft, 27th (Denver) Air Division, by type and altitude strata (peak hour of a peak VFR day) 1960-75

Year	Type	<15,000	15,000–24,000	>24,000	Total
1960	Air Carrier	35	21	11	67
	Military Itinerant	160	36	84	280
	Military Local	623	142	328	1,093
	General Aviation	194	8	0	202
	Total	1,012	207	423	1,642
1965	Air Carrier	36	31	25	93
	Military Itinerant	93	21	49	163
	Military Local	363	83	191	637
	General Aviation	246	22	1	269
	Total	738	157	266	1,162
1970	Air Carrier	27	39	31	98
	Military Itinerant	81	19	43	143
	Military Local	316	72	166	554
	General Aviation	304	47	8	358
	Total	728	177	248	1,153
1975	Air Carrier	38	55	37	130
	Military Itinerant	68	16	36	120
	Military Local	265	60	140	465
	General Aviation	354	71	17	442
	Total	725	202	230	1,157

Fig. 26. Estimated instantaneous airborne aircraft, 28th (Los Angeles) Air Division, by type and altitude strata (peak hour of a peak VFR day) 1960–75

Year	Type	<15,000	15,000-24,000	>24,000	Total
1960	Air Carrier	5	3	2	10
	Military Itinerant	9	2	5	16
	Military Local	9	2	5	16
	General Aviation	33	1	0	34
	Total	56	8	12	76
1965	Air Carrier	5	5	4	14
	Military Itinerant	7	1	3	11
	Military Local	7	2	4	13
	General Aviation	41	4	0	45
	Total	60	12	11	83
1970	Air Carrier	4	6	5	15
	Military Itinerant	6	1	3	10
	Military Local	6	2	3	11
	General Aviation	51	8	1	60
	Total	67	17	12	96
1975	Air Carrier	6	8	6	20
	Military Itinerant	5	1	3	9
	Military Local	5	1	3	9
	General Aviation	59	12	3	74
	Total	75	22	15	112

Fig. 27. Estimated instantaneous airborne aircraft, 29th (Great Falls) Air Division, by type and altitude strata (peak hour of a peak VFR day) 1960-75

Year	Type	< 15,000	15,000-24,000	>24,000	Total
1960	Air Carrier	154	92	51	297
	Military Itinerant	175	40	92	307
	Military Local	286	65	150	501
	General Aviation	908	38	0	946
	Total	1,523	235	293	2,051
1965	Air Carrier	161	140	111	412
	Military Itinerant	133	30	70	233
	Military Local	219	50	116	385
	General Aviation	1,149	100	7	1,256
	Total	1,662	320	304	2,286
1970	Air Carrier	122	174	139	435
	Military Itinerant	116	27	61	204
	Military Local	191	43	101	335
	General Aviation	1,423	218	33	1,674
	Total	1,852	462	334	2,648
1975	Air Carrier	167	242	167	576
	Military Itinerant	97	22	51	170
	Military Local	160	37	84	281
	General Aviation	1,650	330	82	2,062
	Total	2,074	631	384	3,089

Fig. 28. Estimated instantaneous airborne aircraft, 30th (Chicago) Air Division, by type and altitude strata (peak hour of a peak VFR day) 1960-75

Year	Type	<15,000	15,000-24,000	>24,000	Total
1960	Air Carrier	16	10	5	31
	Military Itinerant	11	3	6	20
	Military Local	19	4	10	33
	General Aviation	121	5	0	126
	Total	167	22	21	210
1965	Air Carrier	17	15	11	43
	Military Itinerant	9	2	4	15
	Military Local	15	3	8	26
	General Aviation	153	13	1	167
	Total	194	33	24	251
1970	Air Carrier	13	18	14	45
	Military Itinerant	7	2	4	13
	Military Local	13	3	7	23
	General Aviation	189	29	4	222
	Total	222	52	29	303
1975	Air Carrier	17	25	18	60
	Military Itinerant	6	1	3	10
	Military Local	11	3	6	20
	General Aviation	219	44	11	274
	Total	253	73	38	364

Fig. 29. Estimated instantaneous airborne aircraft, 31st (Minneapolis) Air Division, by type and altitude strata (peak hour of a peak VFR day) 1960–75

Year	Type	<15,000	15,000-24,000	>24,000	Total
1960	Air Carrier	87	52	29	168
	Military Itinerant	189	43	100	332
	Military Local	874	199	459	1,532
	General Aviation	451	19	0	470
	Total	1,601	313	588	2,502
1965	Air Carrier	91	79	63	233
	Military Itinerant	145	33	76	254
	Military Local	668	152	352	1,172
	General Aviation	572	50	3	625
	Total	1,476	314	494	2,284
1970	Air Carrier	69	98	79	246
	Military Itinerant	126	29	66	221
	Military Local	583	132	307	1,022
	General Aviation	709	108	17	834
	Total	1,487	367	469	2,323
1975	Air Carrier	95	137	94	326
	Military Itinerant	106	24	56	186
	Military Local	489	112	256	857
	General Aviation	822	164	41	1,027
	Total	1,512	437	447	2,396

Fig. 30. Estimated instantaneous airborne aircraft, 32nd (Atlanta) Air Division, by type and altitude strata (peak hour of a peak VFR day) 1960-75

Year	Type	<15,000	15,000-24,000	>24,000	Total
1960	Air Carrier	43	25	14	82
	Military Itinerant	187	43	99	329
	Military Local	569	130	299	998
	General Aviation	399	17	0	416
	Total	1,198	215	412	1,825
1965	Air Carrier	44	39	31	114
	Military Itinerant	144	33	75	252
	Military Local	435	99	229	763
	General Aviation	505	44	3	552
	Total	1,128	215	338	1,681
1970	Air Carrier	34	48	39	121
	Military Itinerant	125	29	66	220
	Military Local	379	86	200	665
	General Aviation	626	96	14	736
	Total	1,164	259	319	1,742
1975	Air Carrier	46	67	47	160
	Military Itinerant	105	24	55	184
	Military Local	318	72	168	558
	General Aviation	726	145	36	907
	Total	1,195	308	306	1,809

Fig. 31. Estimated instantaneous airborne aircraft, 33rd (San Antonio) Air Division, by type and altitude strata (peak hour of a peak VFR day) 1960-75

Air Division	Below 15,000 ft.			15,000–24,000 ft.			Above 24,000 ft.			Total		
	Low	Peak	Medium	Low	Peak	Medium	Low	Peak	Medium	Low	Peak	Medium
Chicago (30th)												
AC	37	161	161	32	140	140	26	111	111	95	412	412
MI	7	133	94	2	30	21	4	70	50	12	233	165
ML	9	219	46	2	50	10	5	116	24	15	385	81
GA	69	1149	368	6	100	32	0	8	3	75	1256	402
Total	122	1662	669	42	320	203	35	305	188	197	2286	1060
Atlanta (32nd)												
AC	21	91	91	18	79	79	15	63	23	54	233	233
MI	7	145	103	2	33	23	4	76	54	13	254	180
ML	27	668	140	6	152	32	14	352	74	47	1172	246
GA	34	572	183	3	50	16	0	3	1	37	625	200
Total	89	1476	517	29	314	150	33	494	152	151	2284	859
New York (26th)												
AC	24	106	106	21	92	92	17	74	74	63	272	272
MI	4	74	53	1	17	12	2	39	28	6	130	92
ML	8	196	41	2	45	9	4	103	22	14	344	72
GA	43	720	230	4	63	20	0	4	1	47	787	252
Total	79	1096	430	28	217	133	23	220	125	130	1533	688
San Antonio (33rd)												
AC	10	44	44	9	39	39	7	31	31	26	114	114
MI	7	144	102	2	33	23	4	75	53	13	252	179
ML	17	435	91	4	99	21	9	229	48	30	763	160
GA	30	505	162	3	44	14	0	3	1	33	552	177
Total	64	1128	399	18	215	97	20	338	133	102	1681	630

Fig. 32. Estimated aircraft in flight, peak VFR day, 1965

Air Division	Below 15,000 ft.			15,000-24,000 ft.			Above 24,000 ft.			Total		
	Low	Peak	Medium	Low	Peak	Medium	Low	Peak	Medium	Low	Peak	Medium
Los Angeles (28th)												
AC	8	36	36	7	31	31	6	25	25	21	93	93
MI	5	93	66	1	21	15	2	49	35	8	163	116
ML	14	363	76	3	83	17	8	191	40	25	637	134
GA	15	246	79	1	22	7	0	1	0	16	269	86
Total	42	738	257	12	157	70	16	266	100	70	1162	429
Minneapolis (31st)												
AC	4	17	17	3	15	15	3	11	11	10	43	43
MI	0	9	6	0	2	1	0	4	3	1	15	11
ML	1	15	3	0	3	1	0	8	2	1	26	5
GA	9	153	49	1	13	4	0	1	0	10	167	53
Total	14	194	75	4	33	21	3	24	16	22	251	112
Denver (27th)												
AC	3	14	14	3	12	12	2	10	10	8	36	36
MI	1	27	19	0	6	4	1	13	9	2	46	33
ML	1	14	3	0	3	1	0	8	2	1	25	5
GA	5	86	28	0	8	3	0	0	0	6	94	30
Total	10	141	64	3	29	20	3	31	21	17	201	104
Seattle (25th)												
AC	3	12	12	3	11	11	2	8	8	8	31	31
MI	1	24	17	0	5	4	1	12	9	2	41	29
ML	2	59	12	1	14	3	1	31	6	4	104	22
GA	3	48	15	0	4	1	0	0	0	3	52	17
Total	9	143	56	4	34	19	4	51	23	17	228	99

Fig. 32 (Cont.). Estimated aircraft in flight, peak VFR day, 1965

Air Division	Below 15,000 ft.			15,000–24,000 ft.			Above 24,000 ft.			Total		
	Low	Peak	Medium	Low	Peak	Medium	Low	Peak	Medium	Low	Peak	Medium
Great Falls (29th)												
AC	1	5	5	1	5	5	1	4	4	3	14	14
MI	0	7	5	0	1	1	0	3	2	1	11	8
ML	0	7	1	0	2	0	0	4	1	0	13	3
GA	2	41	13	0	4	1	0	0	0	3	45	14
Total	3	60	24	1	12	7	1	11	7	7	83	39
U. S. Totals												
AC	112	487	487	98	424	424	78	337	337	288	1248	1248
MI	33	656	466	7	148	105	17	341	242	57	1147	814
ML	79	1976	415	18	451	95	42	1042	219	139	3467	728
GA	211	3520	1126	18	308	99	1	19	6	231	3847	1231
Total	435	6639	2494	141	1331	723	138	1739	804	715	9709	4021

Fig. 32 (Cont.). Estimated aircraft in flight, peak VFR day, 1965

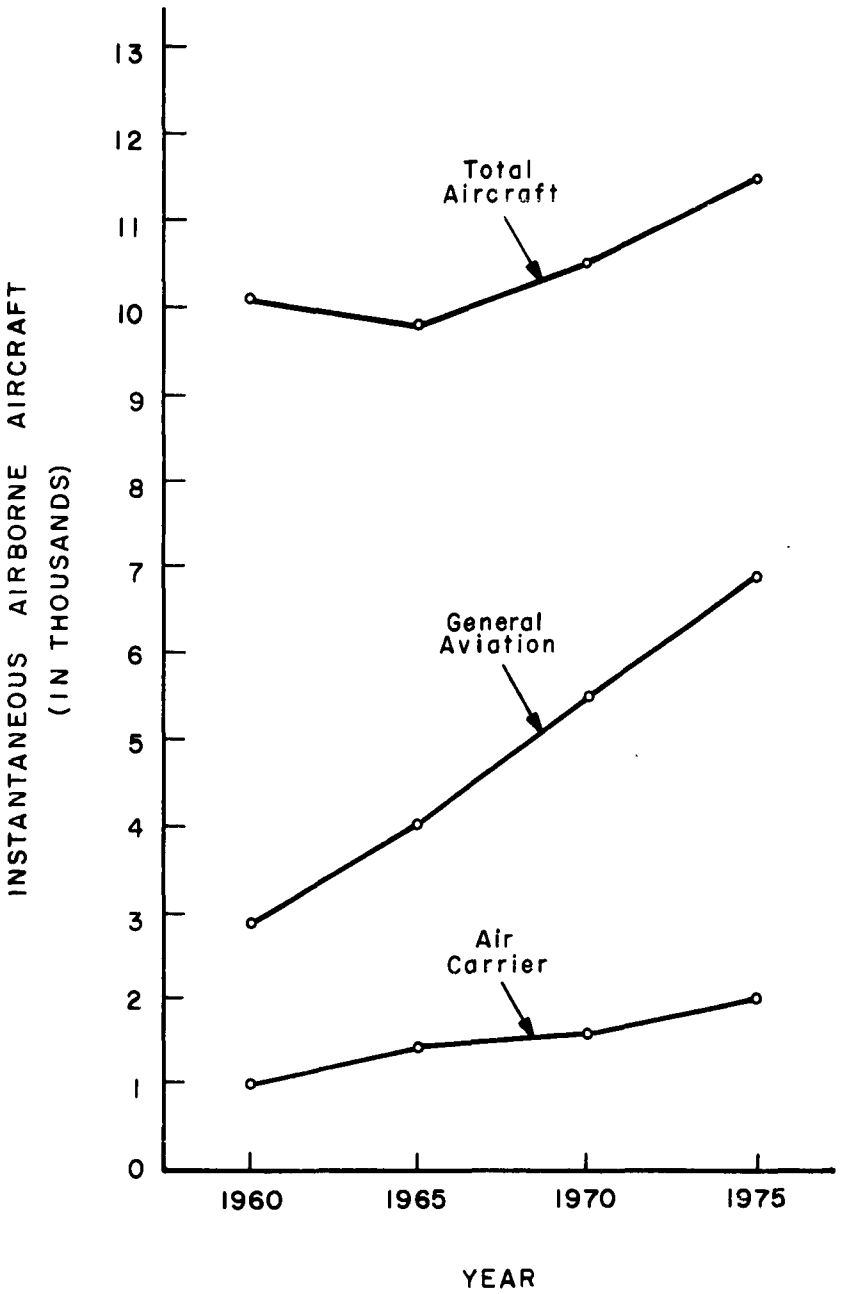


Fig. 33. Estimated nationwide instantaneous airborne aircraft (peak hour of a peak VFR day) 1960-75

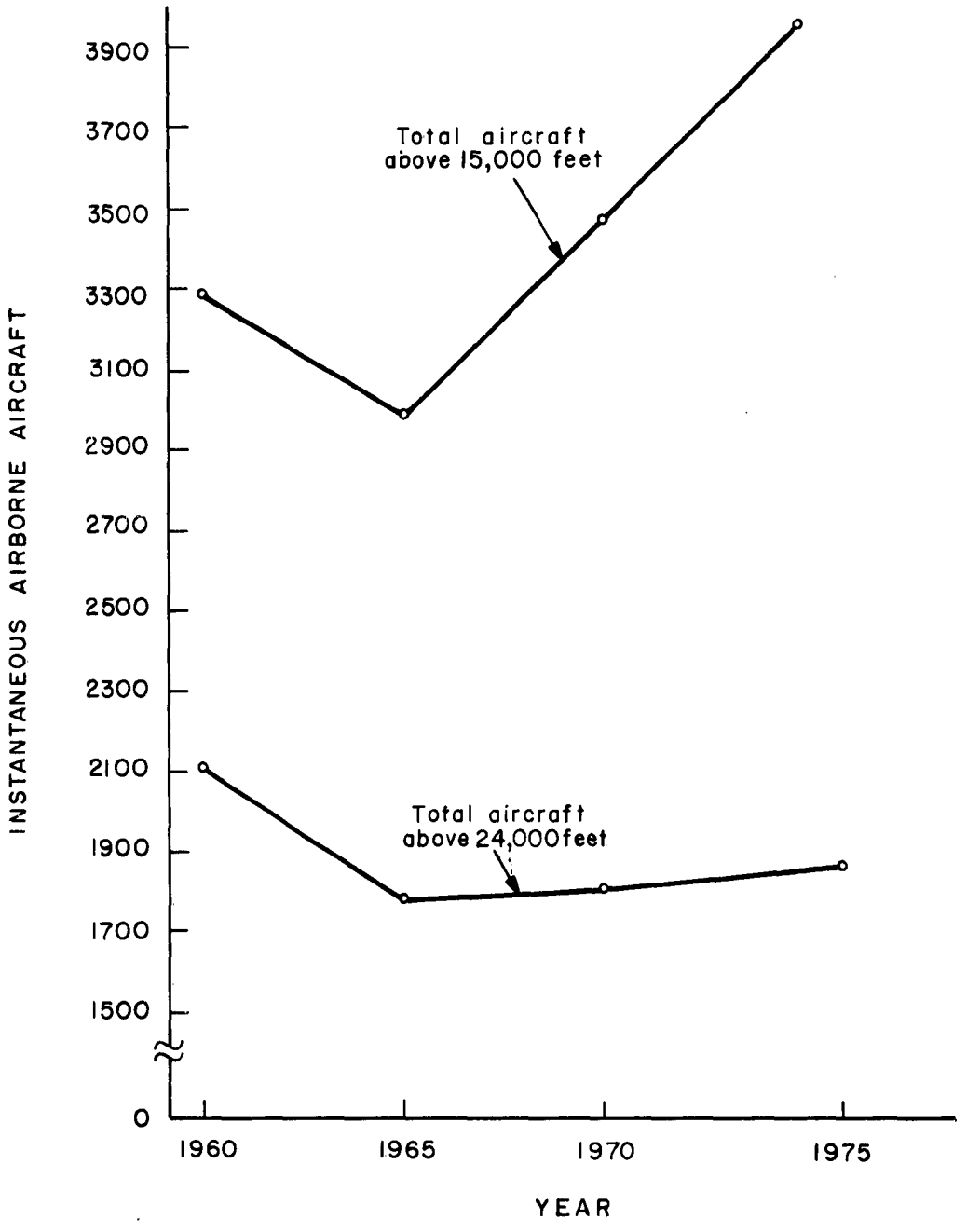


Fig. 34. Estimated total nationwide instantaneous airborne aircraft above 15,000 and 24,000 feet (peak hour of a peak VFR day) 1960-75

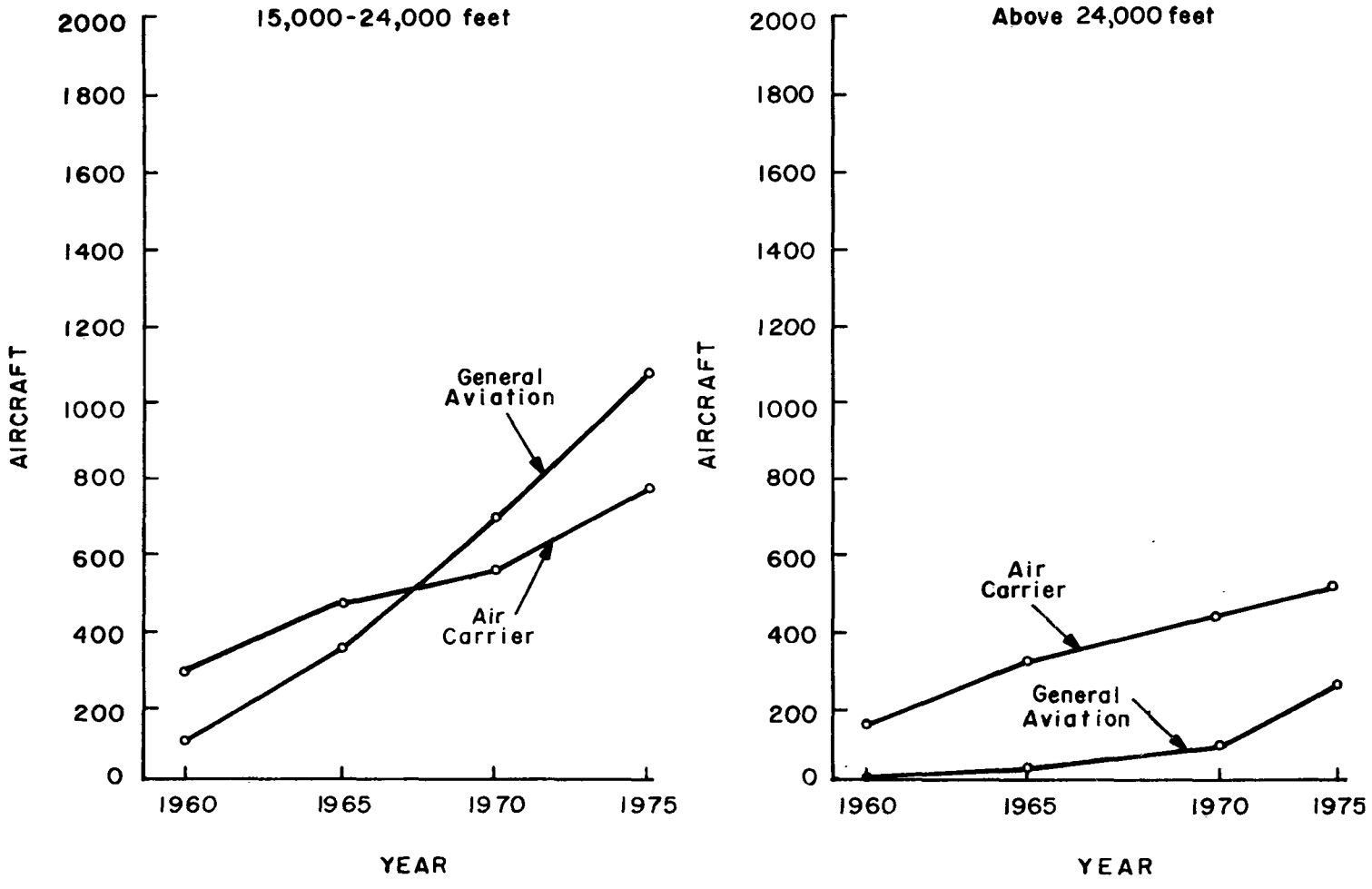


Fig. 35. Estimated total nationwide instantaneous airborne aircraft by type and altitude strata (peak hour of a peak VFR day) 1960–75

Air Division	Year 1960	1965	1970	1975
30th (Chicago)	2,051	2,286	2,648	3,089
32nd (Atlanta)	2,502	2,284	2,323	2,394
26th (New York)	1,409	1,533	1,750	2,020
33rd (San Antonio)	1,825	1,681	1,742	1,809
28th (Los Angeles)	1,642	1,162	1,153	1,157
31st (Minneapolis)	210	251	303	364
27th (Denver)	190	201	224	256
25th (Seattle)	252	230	229	235
29th (Great Falls)	76	83	96	112
Totals	10,157	9,711	10,468	11,436

Fig. 36. Estimated instantaneous airborne aircraft in all altitudes by air division (peak hour of a peak VFR day)1960-75

Air Division	Year 1960	1965	1970	1975
30th (Chicago)	293	304	334	384
32nd (Atlanta)	588	494	469	447
26th (New York)	219	220	237	266
33rd (San Antonio)	412	338	319	306
28th (Los Angeles)	423	266	248	230
31st (Minneapolis)	21	24	29	38
27th (Denver)	32	31	33	36
25th (Seattle)	61	51	50	48
29th (Great Falls)	12	11	12	15
Totals	2,061	1,739	1,731	1,770

Fig. 37. Estimated instantaneous airborne aircraft above 24,000 feet by air division (peak hour of a peak VFR day) 1960-75

Air Division	Year 1960	1965	1970	1975
30th (Chicago)	528	624	796	1,015
32nd (Atlanta)	901	703	836	884
26th (New York)	385	437	542	678
33rd (San Antonio)	627	553	578	614
28th (Los Angeles)	630	423	425	432
31st (Minneapolis)	43	57	81	111
27th (Denver)	55	60	72	89
25th (Seattle)	95	85	89	94
29th (Great Falls)	20	23	29	37
Totals	3,284	2,965	3,448	3,954

Fig. 38. Estimated instantaneous airborne aircraft above 15,000 feet by air division (peak hour of a peak VFR day) 1960-75

APPENDIX A

REFERENCES

1. NATIONAL REQUIREMENTS FOR AVIATION FACILITIES: 1956-1975 (CURTIS REPORT)

   Airborne Instruments Laboratory, Aeronautical Research Foundation, and Cornell Aeronautical Laboratory. Washington, Government Printing Office, May, June 1957.

   A. Volume I — Summary
   B. Volume II — Air Traffic
   C. Volume III — Aircraft Characteristics
      Part I — Civil Aircraft
      Part II — Military Aircraft (Secret)
   D. Volume IV — Forecast of Aviation Activity

2. OFFICIAL AIRLINE GUIDE

   Volume 15, No. 9, part 3. June, August 1959.

3. EN ROUTE IFR AIR TRAFFIC SURVEY, PEAK DAY

   U. S. Department of Commerce. Civil Aeronautics Administration. Office of Air Traffic Control. Washington, Government Printing Office, 1957.

4. FEDERAL AIRWAYS AIR TRAFFIC ACTIVITY

   U. S. Department of Commerce. Civil Aeronautics Administration. Planning and Development Office. Washington, Government Printing Office, 1957.

5. SURVEY OF MILITARY POINT-TO-POINT FLYING

   Federal Aviation Agency. Bureau of Research and Development. Washington, Government Printing Office, December 1958 (Confidential).

6. LOCAL MILITARY FLYING

   C-E-I-R, Inc. May 1959. (Prepared for the Federal Aviation Agency, Bureau of Research Development).

7. AIR TRAFFIC DENSITY OVER CONTINENTAL UNITED STATES

   RAND Report TM-66. RAND Corporation, Santa Monica, California 16 January 1956. (Confidential)

8. FEDERAL AIRWAY PLAN: FISCAL YEARS 1959-1963

U. S. Department of Commerce. Civil Aeronautics Administration. Washington, Government Printing Office. p. 5, January 1958.

9. STAFF STUDY VFR TRAFFIC AND ITS IFR RELATIONSHIP

U. S. Department of Commerce. Civil Aeronautics Administration. Washington, Government Printing Office. p. 2, 1955.

10. AIR TRANSPORT FACTS AND FIGURES

Aviation Week, 20th Edition, Volume 70, No. 18, pp. 93-124, 4 May 1959

11. EN ROUTE IFR PEAK DAY-PEAK HOUR RELATIONSHIPS

U. S. Department of Commerce. Civil Aeronautics Administration. Washington, Government Printing Office. January 1958.